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ABSTRACT

The primary objective of this project was to design a responsive environment using a computer-controlled organ for children to learn music principles. Three secondary objectives set in the development of this environment were to create the means for: 1) entering, storing, and replaying complex music; 2) viewing the time-space relationships inherent in music; 3) controlling and manipulating music. A computer-controlled electronic concert organ was programmed to enable a wide variety of musical composition manipulation from changing key to synthesizing musical parts. Line drawings on a graphics scope displayed music information that could be redrawn at will. Music manipulation was accomplished with keyboard, computer terminal, and lightpen buttons. Response from 13 children ages 4-12 and a few adults was very favorable--the graphics scope being especially successful for grasping correlation of parts of a score. The developmental basis of the system shows great potential for generating data to compare with data gathered from traditional teaching methods. (JH)

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Design of an Educational Environment with a Computer-Controlled Organ

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The primary objective of this project was to design a responsive environment using a computer-controlled organ for children to learn music principles. A responsive environment incorporates principles advocated by Jean Piaget and Omar K. Moore. It permits the learner to explore freely, to freely manipulate objects, to receive immediate feedback, to make full use of his capacity for discovering relations of various kinds, and to progress at his own speed.

The project was a developmental attempt to construct a responsive music learning environment. To meet the demands of a responsive music environment, the following objectives were set. The environment should: 1) provide children with a simple means of entering, storing, and replaying complex music; 2) provide children with an easy means of viewing the time-space relationships inherent in music; and, 3) provide controls with which children could modify and manipulate music.

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Entering, storing, and replaying music.- The environment was created using a computer-controlled, electronic concert organ along with a graphics scope and a computer terminal. The organ keys were monitored by the computer and the core storage was used to store representations of music played on the organ. Computer programs were written which were designed to do various complex manipulations of this music data depending on buttons pressed by the subjects. Some operations which the computer could accomplish were: 1) replay the music stored in core; 2) transpose the music into any key; 3) change the speed of the music within a range of extremely slow to extremely fast; 4) play the music in one of various timbres; 5) compare input played from the keyboard with a standard; 6) analyze and separate lines such as melody and bass; and, 7) synthesize two or more sub-parts into one piece of music.

Using the synthesis capability, it was possible to allow subjects to separate a complex piece of music into simpler parts and enter them one at a time. Buttons were provided to make input and control of music easy and clear. Buttons took the form of terminal keys, switches on the computer, lightpen buttons, and even organ keyboard keys could be redefined to be computer command controls.

Viewing time-space relationships.- Along with audio feedback, a visual feedback system was devised. An eighteen inch graphics display scope was connected to the computer so that programs could be written to produce line drawings. The computer was programmed to read the music information from storage or from keyboard input and use this as data to control a dynamically moving, multi-line graph on the scope. The vertical axis on the scope represented frequency or pitch, and the horizontal axis represented the length or time value of a note.

Modifications in the graph as well as the music could be made via the lightpen attached to the graphics scope. As the computer graphed and played music, subjects could stop the graph at a chosen point and command the computer to repetitiously play whatever was left on the screen when stopped. Subjects could then use the lightpen to designate a note on the screen and change either its pitch or its length. After any change, the computer would continue to play the graphed notes but would include the change made by the lightpen. Any number of modifications were possible.

Since this was a developmental project, no attempt was made to gather measurable data. Observations of thirteen children ranging from ages four to twelve were made, and their comments as well as their music were recorded on tape. Instructions were given to show subjects which buttons controlled the various operations. The subjects worked in groups as well as individually. The project was mainly concerned with children although some adults were also observed.

Comments by the subjects were favorable and excited. The subjects were able to understand and use the control buttons to manipulate, rearrange, and modify music. The graphics scope was a major success in giving feedback to the subjects which they could visually correlate with the music. The older children used the graphics as a means to compare the activity of the bass in relationship to the activity of the melody. The contour of Bach pieces was especially informative since in counterpoint the theme is often played in several lines, each one delayed a few bars behind the next as in a round. Exact relationships of the themes were easily seen on the graphics scope. Younger children were able to see the relationship of the keys of the organ keyboard and the pitch position on the screen. The graphing made other musical ideas such as transposition conceptually easy to grasp. The buttons which transposed music into different keys were used to shift the graph up or down depending on the transposition.

A system has been developed and shown on a developmental basis to be potentially useful. The system provides means for generating data in a responsive environmental setting which can be compared with data gathered from traditional music teaching methods.